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ABSTRACT

There are several efforts today in the United States to explore and develop new educational applications for both the main frame computers and the microcomputers, especially in the development of instruction for the culturally disadvantaged and the handicapped. Recent developments for the visually impaired include using high speed braille-terminals connected to a central computer, and a talking calculator which uses synthesized speech to interpret keys pressed and results displayed. New technology for the hearing impaired includes a touch sensitive screen to take programs ranging from Spelling Bee to Calculator, and a video interactive device to teach lip reading skills. Computer assisted instruction, consisting mainly of drill and practice, has also been successfully used for the mentally handicapped and learning disabled children at the elementary and junior high school levels. Efforts to help the physically disabled have resulted in a speech synthesizer, and a graphic display screen used in conjunction with a hand-held pen. An additional function of the computer has been to diagnose and prescribe instruction for the handicapped, and to support individualized programs for emotionally disturbed students. Forty references are included. (Author/BK)

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# AN UPDATE ON COMPUTERS IN THE CLASSROOM

by

Robert J. Walker

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ENIAC, the first general purpose digital electronic computer became operational in December 1945. In 1951 computers became commercially available. In the 1960's hardware and software were readily available. Timeshare computing and minicomputers also came into being in the 1960's. A battery powered computer, programmable in BASIC became available in 1980 for about $250. In the 1960's leaders in the field of computer and information science began to suggest all people needed to know something about computers. Computer literacy thus came into being.[28] According to Bukoski and Korotkin[2] 70% of all college students are now enrolled in institutions having computing facilities. At the secondary level 58% of all secondary schools now actively utilize computers. Of these 54% utilize the computer for administrative purposes, while 46% of them utilize it for both instruction and administration. These figures today are even higher. Schools are purchasing small computers (micros) at a very rapid rate. The number in any one school is often small, but a recent study by Chambers and Bork of 50 states indicated that over 90% of the districts responding to the survey (over 60%) claimed to have some computer capacity at the present time.[4]

The use of computers is widespread. The Federal Government is the largest single user of computers in the United States. The Government has 10,000 computers and spends approximately 10 billion dollars a year on equipment and personnel. Computers have become indespensable to the operation of government.[25] The computer age is upon us. Computers are everywhere from the supermarket to the gas station. People are being educated about computers through daily living. Our technological society needs to have workers skilled in the use of the computer. Andrew Molnar concludes that there is:

> *". . . a national need to foster Computer Literacy. Further, if we are to meet this need, we must ensure that high school graduates have an understanding of the uses and applications of the computer in society and its effect upon their everyday lives. . . . A nation concerned with its social needs and economic growth cannot be indifferent to the problems of Literacy. If we are to reap the benefits of science - driven indsutries, we must develop a computer - literate society."*

Dr. Kenneth E. Brumbaugh defines Computer Literacy:

*To be computer literate one must be able to define, demonstrate, and/or discuss:*

*how computers are used*
*how computers do their work*
*how computers are programmed*
*how to use a computer*
*how computers affect our society*

Beverly Hunter of the Human Resources Research Organization defined Computer Literacy functionally as

*"whatever a person needs to know and do with computers in order to function competently in our information based society."*

This trend or movement (Computer Literacy) is becoming very popular throughout the world. There are several movements in the United States to see that our students will be educated in the use of the computer. The Human Resources Research Organization (HUMRRO) and the Minnesota Educational Consortium (MECC) have both received National Science Foundation (NSF) grants to develop computer literacy materials. HUMRRO's computer literacy guide will be aimed at promoting instructional computing in the elementary school and will establish a scope and sequence for learning outcomes by grade level, subject matter, and topic. They will also provide suggested supplemental activities, resources and training for teachers to consider. MECC computer literacy project will produce 25 student learning modules, including background material, student activities, text material and visual aids. Some of the modules will contain computer-based learning activities designed to run on selected microcomputers.

Minnesota has formed the Minnesota Educational Computing Consortium (MECC). MECC started offering statewide instructional computing services in 1974. Presently they have the largest time-share network of its kind in the world. They are able to serve 400 users simultaneously over telephone lines via terminals. They have also purchased 1,600 APPLE II microcomputers for placement in the schools throughout the state. Inservice training programs for teachers is a big part of their effort. More can be learned about this dynamic effort in the February 1981 issue of PHI DELTA KAPPAN, pages 453-454.

Montgomery County, Maryland school system's educational use of computers was started in the early seventies. They presently have a computer-managed mathematics program (K-8) in 87 schools, serving 34,000 students. They are also, applying microcomputers to education with approximately 175 PET and Ohio Scientific micros. Along with working on the HUMRRO Project they are participating with the Maryland State Department of Education and the U. S. Department of Education on the Beltway Video Disc Project. This project will be applying the video disc recorder technology and the technology of the APPLE II (48K) microcomputer to elementary instruction.

The subject area curriculum specialists are demanding computer training. Watt reports

> *"The National Council for the Social Studies, in its position statement on curriculum, suggests that students be taught data processing skills."*

Computer Literacy should provide in social studies competencies in: social responsibility and values, decision making skills, the use of information in a democractic society and the impact of technology historically and in the future.[12]

The National Council of Teachers of Mathematics after a series of studies funded by the National Science Foundation and from the National Assessment of Educational Progress made eight Recommendations for School Mathematics of the 1980's. Four of the eight speak directly or indirectly to the use of the computer in education. Number 1 says that problem solving be the focus of school mathematics be defined to encompass more than computational facility. Number 3 says that mathematics programs take full advantage of the power of calculators and computers at all grade levels. Finally number 6 reflects both on the computer as well as the disadvantaged and handicapped. It states that more mathematics study be required for all students and a flexible curriculum with a greater range of options be designed to accommodate the diverse needs of the student population.[29]

The application of the computer to science classes has been here for many years. They were first introduced at the university level and have gradually filtered into secondary schools. Karl Zinn states that as computer costs drop, decisions to purchase equipment and assign computer-related activities will be made on the basis of whatever is considered essential to the study of science. Add on

computer facilities will be tested, evaluated, and adopted in the same way that a chesmistry lab idea or microscope exercise has in the past been tested and introduced.[30]

The Arts have adapted the computer to their needs. There is the perspective of making the computer into a tool for the creative activity rather than a presenter of questions and answers. The Xerox Palo Alto Research Center has taken this approach. Children here compose music, create animated cartoons and write stories.[17] Word processing via the computer is another use which can enrich the education of the disadvantaged and handicapped. The word processor can be used for writing a letter or a story to even a thesis or poetry. It is an invaluable tool. It provides a visually attractive finished copy. At a time of declining communication skills this may be the major advantage.[40]

The disadvantaged need access to the tools of our modern society. Not enough has been done to have the computer serve our disadvantaged. Only public schools can help ensure that all citizens have equal access to the opportunity for Computer Literacy education. it is generally the case that schools in more affluent areas are finding it easier to incorporate computers in their educational budgets.[38]

There has been some effort to utilize computers with culturally disadvantaged to their benefit. For example, in Los Nietos, California, studies have been made which show significant improvements in the self concepts of their Spanish speaking children who were enrolled in their computer-assisted instruction programs.[27] In 1974 Bennett College, a southern black women's college, initiated a major project using computers to remediate deficiencies in language arts and math, and to provide Computer Literacy.[26] Both programs were successful. These programs and many like them utilize a tutorial computer application commonly known as computer-assisted instruction (CAI) or computer-aided learning (CAL). This approach presents information on a terminal and then monitors the student's progress through the lesson or curriculum. Tests or assessments are given which direct the student to remediation, drill and practice or new material. This method is widely used but has been expensive. Tutorial use of computers has been undesirable until the advent of the less expensive microcomputer. Careful preparation of the program must control the pace and style of the material to fit the learner. Remediation is seen as an important use of the micro.[40]

There is caution expressed in only using CAI with the disadvantaged. Daniel Watt believes that when computers are introduced into suburban schools computer programming and computer awareness are the courses offered. In less affluent rural or inner city schools computer-assisted instruction is more likely offered. He states,

> *Affluent students are thus lerning to tell the computer what to do while less affluent students are learning to do what the computer tells them."* [33]

We wish now to survey some of the recent applications of computer technology to the education of the handicapped. Public Law 94-142 enacted in November of 1975 has as one of its intents to establish full educational opportunities for all handicapped children. Interest in applying the computer is running high in the United States. Contents like the following are spurring invention in this area: Johns Hopkins University with grant aid from the National Science Foundation and Radio Shack division of Tandy Corporation has instituted a nationwide search for new inventions that apply personal computers to the needs of handicapped people. The grand prize is $10,000. All categories of handicaps, including mental disorders are to be applied.[8]

Consider first, how the visually handicapped can benefit from computer technology. At Gallaudet College in Washington, D. C., they have purchased a triformation LED 120 braille computer terminal and a computer program from Duxbury Systems, Incorporated which converts English text to grade 2 braille. This equipment allows their deaf-blind students to receive braille textbooks and reference materials in a much more timely fashion, to program their time-sharing computer and to obtain continuous braille copy of campus news. They will also be able to have access to computer-aided instructional materials and UPI national and international news. In using the computer the blind student uses a standard keyboard but in addition receives a sheet of paper which is embossed in braille of the character input into the terminal. All interactions are thus carried out in braille. In 1979 Galludet was also planning for sometime in the future to be participating in telecommunication both locally and nationally.[34]

As early as July 1977 Computer Literacy was presented to 15 visually impaired students at the Educational Computer Center of the Bernard M. Baruch College, the City University of New York. Training then in computer technology for the visually impaired was very limited in the New York metropolitan area. In training the students the Computer Center used an LED 120 high speed braille terminal connected to the (CUNY) central computer. The LED 120 is capable of printing braille at 120 characters per second. Also used were three Visualtek CCTV's. The Visualtek devices are capable of greatly enlarging print and displaying the image on a TV monitor. Fortran was the computer language used. In lectures the chalkboard was used heavily. Telescopic viewers, braillers, and cassette tape recordings assisted to record class notes. Handouts were large print for the partically sighted and braille or raised-line Thermoform diagrams for the totally blind students. Many other adaptations were made. The workshop was successful in teaching Computer Literacy. Of equal importance was the growth by the students in confidence, mobility and feelings of accomplishment.[31]

Corporations also are adapting the computer to the visually impaired. Telesensory Systems Incorporate (TSI) has developed a talking calculator which utilizes synthesized speech to interpret the keys pressed and results displayed. They have also developed the OPTACON which converts print into tactile material which can be then read by a trained blind user. They are also developing a text-to-speech device which will translate written materials into spoken words.[37] The Maryland Computer Services Incorporated of Bel Air, Maryland has adapted Hewlett-Packard computers to a talking computer application. Their first application is an automated telephone directory for the blind. This firm has also developed computers which allow blind people to do their own programming. Their machine can be programmed to allow a blind person to fill in all the necessary information for a 1040 tax return, then do all the computations and print out a filled-out form.[20] Arts Associates Incorporated of Boston, Massachusetts, have produced a large print monitor for the visually impaired also. Their devices can be made to simulate DEC operating systems, IBM, Lanier and others with respect to to control codes. Maggs has developed a talking computer terminal that translates the print appearing in computer programming and on the CRT terminal into speech using an inexpensive speech synthesizer device. This project received assistance through a grant in 1978 from the Bureau of Education for the Handicapped.[37] One university is also working with auditory devices. The Office of Research and Extension of the North Carolina State University School of Education is developing a vocal computer-assisted

instruction tutorials (CAI) for blind junior college students. They are using a voice response terminal enabling the computer to train and give feedback to the student. Four thousand students could benefit from this instruction in North Carolina.[39]

The hearing impaired students are also benefitting from computer technology. CAI programs are particularly beneficial. Von Feldt in 1977 found 34 institutions using computers for the instruction of the hearing impaired.[36] The Learning Center for Deaf Children in Framingham and the Boston School for the Deaf in Randolph are currently using CAI programs via the computer to meet the unique language needs of their students. Both schools use a language program which is on the student's ability level. (ILIAD at the Boston School for the Deaf is the system where children are challenged to experiment with new vocabulary and sentence patterns.) At the Learning Center children use a touch senstive screen to take programs ranging from Spelling Bee to Calculator. Mail at Framingham allows the students to compose letters and receive replys.[16] The Control Data Corporation together with the Colorado Hearing and Speech Center in Denver are using a CAI system utilizing PLATO. Their lessons provide drill and practice in visual memory skills areas. The Clarke School for the Deaf, also in Boston, is testing computer controlled speech aid programs developed by Bolt, Beranek and Newman. The Stanford Mathematic Strand CAI curriculum in English and Mathematics have been used at Galludet since 1977. The Kendall Demonstration Elementary School on Galludet's campus is currently using a computer system as part of their instructional program. The California School for the Deaf at Berkeley has been utilizing computer-assisted instruction since 1970. In 1978 they received a federal grant to establish a regional center for CAI development. Their CAI laboratory and the school includes 12 terminals which are time shared with a NOVA-ECLIPSE computer. Because of portability they are also using an APPLE II in the nearby schools in the Bay area. The California School for the Deaf at Riverside are using a NOVA III/VII computer with a RAMTEK 6,000 colorgraphic terminal to teach language skills.[37] At the National Technical Institute for the Deaf they have been using a Video Interactive Device (DAVID) to teach lip reading skills since 1968. This system uses a Wang VP mini-computer, a keyboard, a disk storage system, a printer and a VTR. This system shows promise and is currently performing as well as conventional methods of teaching lip reading.[33]

Curriculum materials are not always easily found for the hearing impaired. Ashcroft reports that computers are being used to produce a data bank of media materials for deaf students, media materials for the training of teachers of the deaf and curriculum evaluation resources. This is being sponsored by the National Center for Educational Media/Materials for the Handicapped.[1]

Much of what is known about the learning characteristics of mentally handicapped children indicates that CAI should be an extremely useful tool in their instruction. ASSIST is a CAI program used with 200 handicapped elementary and junior high students in Cupertino Union School District, California. In this program teachers authored computer lessons using a computer program. The lessons were drill and practice supplementing the teacher's classroom instruction. Student performance on the lessons is recorded by the computer. Students could also send messages to fellow students over the terminal. Four types of handicapped students were served: (1) the educable mentally retarded (EMR), (2) the educationally handicapped minors (EHM), (3) the learning disability group (LDG), and (4) the severe oral language handicapped (SOLH). Half of the students belonged to the LDG group and the remaining half were equally divided into the other three groups. In 1978 there were 975 lessons available at the end of the project. Of these 164 were produced prior to operation. Fourteen participating teachers averaged 57 lessons per teacher. The most frequently used drill was a method of presenting vocabulary words and giving practice in spelling. Another popular drill was a fill in the blank program. The treatment group gains were positive in 3/4 of the cases and significant at the 80% level in nearly half the cases.[3]

Efforts to help the physically disabled with the computer have come many times from outside the U. S. A speech synthesizer has been developed by Ron Palmer and other Telephone Pioneers from Regina, Saskatchewan, Canada. This computer was developed to help severely disabled cerebral palsy victims communicate.[3] In Australia the Woden School in Canberra, as part of a collaborative project with the Australian National University Department of Engineering Physics, has developed a computer system to teach handwriting to intellectually handicapped students. Their computer has a DIGIVUE graphic display screen on which lines, text and other material can be displayed. Associated with this screen is a hand-held "pen," the position of which can be determined by the computer. The computer

calculates the pen position using the lengths of two fine strings attached to the pen just above the tip. This system is suggested for rehabilitation of patients who have suffered brain and/or limb damage and who have to relearn perceptual and fine motor skills.[21] Here in the U. S. the APPLE microcomputer has also been adapted to the physically disabled who cannot speak, write, or type. A single keystroke by finger or mouthstick will display a sentence chosen from 60 programmed sentences which can be changed. There is a possibility of a 1600 word vocabulary.[24] There has been a method to enter data via a PET microcomputer by a single key entry. This method can be used by whatever muscle a person can control on severely handicapped people. On the screen will be a line of characters. The person will select the appropriate character until the desired message is built.[6]

Satellites have been suggested to transmit teacher training programs to regional centers having computer terminals. One such proposal is the Computer-Based Education Utility (CBEU). Legislation and litigation in all 50 states of the union generally termed "right to education" laws have created a new trust in providing training to classroom teachers to learn how to teach mildly handicapped children. At the regional center the CBEU program would present material and request a response to a question from the teacher. By this CAI method the plan is designated as being interactive. This plan is now in the proposal stage and is proposed to be paid for by government subsidy and user fee.[14]

The computer can help in decision making in the diagnosis and prescription of the handicapped. A computer program in Fortran was developed at the Institute of Child Study at Kean College for the purpose of generating individualized diagnostic and prescriptive reports on several hundred preschoolers screened for learning disabilities. Nineteen subtests scores were recorded. These scores were then key punched for each student. From this data a meaningful sequence of diagnostic and prescriptive type narrative statements, corresponding to each subtest was produced for each child wherever appropriate. These problem areas, thus printed, will hopefully be attended to by the school and parents.[19] Another prescriptive use of the computer is Project Orpheus at the Orchard School in Yonkers, New York. They have a computerized process for developing, managing, and supporting the individualized education programs (IEP's) of emotionally disturbed children. The Direction Service Project in Fairfax County Public Schools, Springfield, Virginia, has a computer based information system designed to

specifically match the varying needs of handicapped children and their families with services, agencies and information most appropriate to their needs.[10]

Although my study of the application of the computer was broad it is not complete. There have been many CAI applications for example. To many to review all of them. I have stressed ones which have deserved recognition. Computers are also important internationally.

More than 10,000 people from 82 countries will be attending the Third World Conference on Computers in Education, July 27-31, 1981, in Lausanne, Switzerland. This conference will place emphasis on computer application and use in primary, secondary, and university education as well as vocational training. This conference is organized by the Swiss Federation of Automatic Control, on behalf of the International Federation for Information Processing (IFIP) and has the backing of UNESCO and the Intergovernment Bureau for Informatics, Rome.

Some of the many topics to be addressed at the conference which have implications on U. S. education are:

*Should we equip secondary schools with a main frame computer and terminals or rather with lots of micro-computers?*

*The role of networks in education*

*Which new technical developments will have a significant impact on education in the next 5 years?*

*The present and future of Computered Aided Learning (CAL)*

*Computer Literacy*

*Reviews of national policies and models of computer education*

*Instructional Techniques*

*Social Impacts*

A number of foreign governments are working cooperatively with commercial firms and educational institutions. They are adopting new educational methods which make the computer an integral part of the educational process from kindergarten to the university. England recently committed 9 million pounds (about $25 million) to its effort on computers in the schools. France has a program it calls "Ten Thousand Microcomputers in the Schools." Germany and Japan have also invested heavily in high stakes high technology.[5] We must keep informed about what our competitors are doing in computer application. According to Maples, who visited China in October of 1980, the Chinese have purchased many microcomputers. He feels that the biggest usage of microcomputing in China today is for training the University students and the practicing engineers and scientists.

By 1982 3 million microcomputers will have been sold and the model current at the time will have double today's power at the same price as today's model.[27]

> *"Personal computers and special purpose computer devices will find their way into the homes of many people for family business, household management, intellectual and educational development, recreational activities and creative expression."* [38]

All students including the disadvantaged and handicapped should benefit. American education should use the computer to the student's best advantage. How computers are best utilized in the schools is a question which deserves thorough study.

## REFERENCES


1. Ashcroft, S. Testimony to the House Committee on Science and Technology, Special Sessions on the Utilization of Computers in Aiding the Education of the Handicapped, Washington, D. C., October 1977.

2. Bukoski, W. J. & Korotkin, A. L., "Computing activities in secondary education," Educational Technology, January 1976.

3. Bates, M. & Wilson, K., "A generative computer system to teach language to the deaf," Proceedings of the Association for Development of Computer Based Instructional Systems, Vol II, San Diego, California 1979.

4. Bork, Alfred, "Computer Literacy for Teachers," Educational Technology Center, University of California, Irvine, California 92717, November 19, 1980.

5. Braun, Lud, "My View of the Need and An Approach to Meeting It," paper presented at Human Resources Organization Computer Literacy Conference, December 18, 1980.

6. Bruez, Alfred J., "Microcomputer Hardware for the Handicapped," Kilobaud Microcomputing, November 80, No. 47, pages 173-174.

7. Brumbaugh, Kenneth E., Computer Literacy, Minnesota Educational Computing Consortium, St. Paul, Minnesota.

8. Chase, Scott, "Contest Seeks Computer Aid for the Handicapped," Washington Post, Washington Business, December 1, 1980, page 3.

9. Chiang, Alice; and others, Demonstration of the Use of Computer-Assisted Instruction with Handicapped Children, Final Report, RMC Research Corporation, Arlington, Virginia, September 1978.

10. The Council for Exceptional Children 58th Annual International Convention Program, Philadelphia, Pennsylvania, April 20-25, 1980, pages 50, 95.

11. Creative Computing, "Computerized Clown Serves as Teaching Toy," Vol 4, No 4, July-August 1978, page 74.

12. Diem, Richard, Computer Literacy in the Social Studies Classroom, University of Texas at San Antonio, December 19, 1980.

13. Fish, Raymond M; Fish, Ronald C., "An Electronically Generated Audio Display for the Blind," New Outlook for the Blind, Vol 70, No 7, 1976, pages 295-8.

14. Hall Keith A.; Mitzel, Harold E., Interactive Computer-Based Education for Satellite Application, paper presented at the Conference on Educational Applications of Satellites (Arlington, Virginia, February 2-3, 1977)

15. Hunter, Beverly, An Approach to Integrating Computer Literacy Into K-8 Curriculum, Human Resources Research Organization, 300 North Washington Street, Alexandria, Virginia 22314, June 1980.

16. Katz, Jeffrey, "Special Tools for Special Needs," Classroom Computer News, November-December 1980, pages 12-13.

17. Kay, A. & Goldberg, "A Personal Dynamic Media," Computer, Vol 10, No 3, pages 31-41, 1977.

18. Klassen, D. L., Anderson, R. E., Hansen, T. P. & Johnson, A Study of Computer Use and Literacy in Science Education, Final Report, St. Paul Minnesota: MECC, 1980.

19. Lavine, Stephen B., "A diagnostic-Prescriptive Computer Program for Pupil Screening," Educational Technology, Vol 17, No 8, pages 37, 1977.

20. Love, Thomas, "Computers That Talk and Print," Washington Star, April 24, 1979, D-5.

21. Macleod, Iain; Procter, Peter, "A Dynamic Approach to Teaching Handwriting Skills," Visible Language, Vol 13, No 1, pages 29-42, 1979.

22. Maples, M. Dundee, "Microcomputers In The People's Republic of China," Recreational Computing, Vol 9, No 4, January-February 1981, pages 22-23.

23. Michael, E. N., The Unprepared Society, Basic Books, Inc., 1968.

24. Microcommunicator, "New Software," Kilobaud Microputing, November, No 47, page 20, 1980.

25. Molnar, Andrew R., "National Policy Toward Technological Innovation and Academic Computing," The Journal: Technological Horizons in Education, Vol 4, No 6, September-October 1977, pages 39-43.

26. Molnar, Andrew R., "The next great crisis in American education: Computer Literacy," The Journal: Technological Horizons in Education, Vol 5, No 4, July-August 1978, pages 35-39.

27. Morgan, Catherine, Research and Educational Implications of the Microelectric Revolution, May 1980.

28. Moursund, David, Personal Computing for Elementary and Secondary Schools, University of Oregon, Eugene Oregon, 1980.

29. National Council of Teachers of Mathematics, An Agenda for Action, the National Council of Teachers of Mathematics, Inc., 1906 Association Drive, Reston, Virginia 22091, pages 1-23, 1980.

30. Rowe, Mary Budd, Ed., What Research Says to the Science Teacher, Vol 2, Information Analysis Center for Science, Mathematics and Environmental Education, Columbus, Ohio, National Science Teachers Association, Washington, D. C., 1979.

31. Ryan, Samuel G.; Bedi, Dina N., "Toward Computer Literacy for Visually Impaired Students," Journal of Visual Impairment and Blindness, Vol 72, No 8, pages 302-06, October 1978.

32. Shribman, David, "Reaching Out to Help," Washington Star, September 23, 1980, C - 1.

33. Sims, Donald; and others, "A Pilot Experiment in Computer Assisted Speechreading Instruction Utilizing the Data Analysis Video Interactive Device (DAVID)," American Annals of the Deaf, Vol 124, No 5, pages 618-23, September 1979.

34. Torr, Donald, "Computer-Supported Braille Applications," American Annals of the Deaf, Vol 124, No 5, pages 691-95, September 1979.

35. U.S. Industrial Outlook, 1976, Washington, D.C.:U.S. Department of Commerce, 1976.

36. Von Feldt, James R. "A National Survey of the Use of Computer Assisted Instruction in Schools for the Deaf," Journal of Educational Technology Systems, Vol 7 (1), pages 29-38, 1978-79.

37. Watson, Paul G. "Utlization of the Computer with Deaf Learners," Educational Technology, Vol 18, No 4, pages 47-9, 1978.

38. Watt, Daniel H., Education for Citizenship in a Computer-Based Society, MIT LOGO Group, Brookline Public Schools.

39. Wilkinson, William K.; and others, CAI for the Visually Handicapped: Promising Collaraboration Between Two and Four-Year Schools, ERIC Document: ED 129351, 1976.

40. Zinn, Karl L., "Personal Computers at the University of Michigan and an an Assessment of Potential Impact," Creative Computing, Vol 4, No 5, pages 84-87, September-October 1978.